Report No. SS10-04 **August 31st, 2010**
File No. 3420

To: Teresa McClung, Calaveras District Ranger, Stanislaus National Forest

Subject: Evaluation of Stands Proposed for Management in the Bailey Ridge Plantation Health Improvement Project, Calaveras Ranger District, Stanislaus National Forest

At the request of Jim Junette, Calaveras Ranger District Resource Management Program Area Leader, I (Joel Egan, Forest Health Protection Entomologist) conducted an evaluation of general stand health in plantations proposed for treatment on the Calaveras Ranger District, Stanislaus National Forest (STF) on June 22nd, 2010. The objective of this visit was to assess current stand conditions and provide recommendations to improve plantation resilience to exogenous disturbance agents for the Bailey Ridge Planation Health Improvement Project. This report summarizes: 1) stand characteristics of units proposed for treatment, 2) insect and disease activity documented in the proposed project and spatially adjacent areas, and 3) recommendations to reduce hazardous stand conditions associated with bark beetle-caused tree mortality.

District personnel provided the following management objective, derived from the Stanislaus National Forest Land and Resource Management Plan (Forest Plan) and the Two Forks Landscape Analysis, to base recommendations on:

- Enhance the general health of plantations and forested stands by reducing susceptibility to insect, disease, and drought-related mortality by improving and promoting stand and individual tree growth and vigor.

Observations

Stand Characteristics for Bailey Ridge Plantations Proposed for Thinning

Plantations proposed for treatment are located throughout the area surrounding Bailey Ridge (Appendix A - Map). Project area land designation is general forest and plantations are adjacent to high-value California spotted owl (*Strix occidentalis*) and northern goshawk (*Accipiter gentilis*) protected activity centers and northern goshawk home range activity corridors. Plantations incorporated an equal proportion of stands within two distinct age/diameter classes (hereafter referred to as younger and older plantations) (Pictures 1 & 2).

South Sierra Shared Service Area
Stanislaus National Forest
19777 Greenley Road
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Picture 1. Representative photo of younger plantation stem diameters and stand densities.

Younger plantations were ≈ 20 years in age did not have any prior pre-commercial thinning management entries. Species composition was primarily (>80%) ponderosa pine (*Pinus ponderosa*) with lesser amounts of white fir (*Abies concolor*), Douglas-fir (Pseudotsuga menziesii), and/or incense cedar (*Calocedrus decurrens*) that naturally regenerated post-planting. Stand densities averaged 576 trees acre^{-1} (range 233-1300) and trees averaged 7" diameter at 4.5 feet in height (DBH) (range 6 – 9" in anticipated residual trees). Approximately 50% of the smaller stands had significant understory brush component.

Older plantations were ≈ 50 years in age and had previous pre-commercial and/or commercial thinning management entries. Stands generally had a dense overstory of planted pines with lesser amounts of shade-tolerant species that naturally regenerated post-planting. Overstory species composition was primarily (>90%) ponderosa pine with lesser amounts of white fir, incense cedar, and/or sugar pines (*Pinus lambertiana*) present. Understory species averaged ≈ 50% white fir and 50% incense cedar and most stands had low levels of brush species present. Stand densities averaged 313 stand density index (SDI) values (range ≈ 300-375) with overstory trees that averaged 16" DBH (range 12-22" DBH).

<u>Insect Activity and Disease Incidence within Plantations Proposed for Management</u>

Only sporadic, insect activity or disease occurrence was observed within the plantation stands proposed for thinning during our visit. In stand #3, a 6" DBH ponderosa pine had successful 2010 western pine beetle (*Dendroctonus brevicomis*) (WPB) attacks around the circumference of its bole.

Picture 2. Representative photo represents older plantation stem diameter and stand densities.

In stand #2, WPBs caused mortality in a 9" DBH ponderosa pine in 2009. Attacked trees in both stands were spatially adjacent to snow breakage that occurred after structural top failure in ≈ 1-2 trees acre^{-1}.

Ponderosa pines within and surrounding stand #27 had symptoms of the Elytroderma foliage and branch disease caused by *Elytroderma deformans*. Older, infections were apparent in branches that had deformations known as "witches' brooms" (Picture 3). Newer infections were extensively noted in 2009-year needles. Infected needles had symptomatic necrotic lesions or browning in ≈ 80% of each needle that progressed from axillary tip towards the fascicle. Majority of needles also evidence of hysterothecia fruiting bodies but laboratory verification did not occur. Intra-tree infection rates averaged 5% of branches (range 5-15%) that were all within the lower 10-15 feet of the crown base. Approximately 15% of all ponderosa pines clustered along a 1/4th mile portion of the stand were infected. This portion of the stand had a topographic depression compared to spatially adjacent areas where no trees had infection symptoms.

Picture 3. *E. deformans*-caused "witches broom".

Picture 4. *E. deformans*-caused needle necrosis.

Insect Activity and Disease Incidence in Stands Adjacent to Bailey Ridge Plantations

In wild (non-plantation) stands between the Bailey Ridge plantations insect and disease activity was observed. WPB-caused mortality was observed in a four sporadic groups of ponderosa pines that faded from 2007-2010. Mortality pockets ranged from 4-15 trees group^{-1}. Effected trees were larger-diameter (>15" DBH) and often had evidence of prior topkill likely caused by *Ips* spp. Mountain pine beetle (*Dendroctonus pondersae*)-caused mortality occurred in ≈ 1 sugar pine per 20 acres from an estimated 2000-2010. Sugar pines were generally larger-diameter (>35" DBH), located in dominant, overstory canopy positions, and surrounded by high densities of understory conifers (Picture 5). Sugar pines also had low levels of white pine blister rust infection (1-5 cankers tree^{-1}) caused by *Cronartium ribicola* in the project area.

Snow breakage of axillary limbs and occasional tops occurred throughout the Bailey Ridge project area in ≈ 6 trees acre^{-1} following wet, heavy snowfall that occurred in Spring 2010. While slash was suitable host material, no evidence of *Ips* spp. colonization was observed during our visit.

Picture 5. MPB-caused sugar pine mortality.

Insect Activity in Forest Creek Plantations near Bailey Ridge Project Area

The Forest Creek area contains ≈ 230 acres of plantation stands that were located ≈ 1.5 miles from the Bailey Ridge area. These plantations were established through artificial regeneration practices in the 1960s. South Sierra Shared Service Area FHP personnel evaluated stand and insect conditions in Forest Creek Plantations on 9/23/08 and 9/17/09. Stands averaged 80% ponderosa pine species composition and were generally overstocked as SDI averaged 349 (range 280-435). Tree diameters averaged 14" DBH (range 8-20").

Extensive WPB-caused ponderosa pine mortality occurred throughout Forest Creek plantations from 2006-2009. Tree mortality was distributed in clumped groups that averaged 30 trees group^{-1} (range 20-100). Overall, 18 groups of mortality were detected from 2006-2009 and ≈ 540 trees killed in the plantation area (CFPC, 2009). Privately-owned, adjacent plantations were recently (≈ 2005) thinned with spacing targets to < 180 feet^2 acre^{-1} of basal area and had no evidence of western pine beetle-caused mortality.

Eight fixed area plots (1/20th acre) were located directly at the center of 2009 Forest Creek plantation grouped mortality pockets in Spring 2010 to assess site-specific stand characteristics associated with WPB-caused tree mortality. Most plots had majority ponderosa pine species composition >70%, high stand densities (>330 SDI), and average tree diameters that exceeded 9" DBH (Table 1).

Table 1. Stand Characteristics Reconstructed Prior to Western Pine Beetle-Caused Tree Mortality from 2006-2009 in the Forest Creek Plantation Area, Calaveras Ranger District, Stanislaus National Forest

# Total Trees Killed in Group	Average DBH (in)	Basal Area ($feet^2$ $acre^{-1}$)[a]	Density (trees $acre^{-1}$)[a]	Stand Density Index (SDI)[a]	Pine Species Composition (% trees $acre^{-1}$)[b]	Lowest DBH WPB Attacked
35	14.8	372	260	539	77%	14.0
5	6.3	145	280	218	71%	14.6
10	14.3	314	240	465	83%	13.6
200	9.1	155	220	246	64%	6.2
200	11.1	292	280	427	64%	6.4
25	9.9	158	220	257	82%	7.5
15	10.4	340	480	564	79%	9.1
25	12.0	313	320	483	69%	8.9

[a] Variables depicting stand density were reconstructed 5 years from 2010 sample date by including recent mortality to represent stand density in 2005 prior to recent tree mortality event.
[b] Percentages calculated from overstory and understory trees & calculations solely based on overstory had greater pine percentages.

Discussion and Management Options

Bailey Ridge Plantation Conditions as of June 2010

Younger and older plantations within the Bailey Ridge area have hazardous stand conditions conducive to bark beetle-caused tree mortality. Stand conditions that can contribute to bark beetle hazard ratings include high stand densities, high levels of host species composition, and large tree diameters (Chojnacky et al., 2000). Stands are overstocked with conifer and, in some locations, brush species. Overstocking reduces inter-tree growing space and creating competition for limited soil moisture and other commodities (Oliver and Larson, 1990). This can lead to low oleoresin exudation pressure, which increases ponderosa pine susceptibility to WPB-caused mortality when attacked (Vite & Wood, 1962). Ponderosa pines in young and old plantations exceed minimum diameter thresholds (6" DBH) for WPB attack (Cochran and Barrett, 1998).

Disease infection can also contribute to intra-tree physiological stress and increase stand or tree hazard regarding bark beetle-caused mortality (Cobb et al., 1974; McCambridge, 1982; Eckberg et al., 1994). However, little disease occurrence or incidence was observed in Bailey Ridge plantations. Infection of *E. deformans* in and around stand #27 was at low levels and this disease typically does not contribute significant amounts of physiological stress until infection levels exceed 40% of all branches in a crown (USDA, 2008).

Management Option – No Action

To-date, younger and older Bailey Ridge plantations have respective moderate and high hazardous stand conditions regarding potential WPB-caused mortality. Forest Creek plantations had similar hazardous stand characteristics as the older Bailey Ridge plantations. Recent WPB-caused tree mortality in the Forest Creek area provide a site-specific case study to illustrate how high levels of bark beetle-caused tree mortality can occur in unmanaged stands with high hazard ratings. Without management activity, hazardous stand conditions in both plantation age classes are projected to increase through time as trees grow to larger diameters and stand density levels increase.

Oliver (1995) indicates the minimum SDI threshold for bark beetle-caused tree mortality in California is 230 SDI and "stands that approach SDI 365 usually suffer large losses from bark beetle epidemics". Recent WPB-caused mortality documented in and surrounding the Bailey Ridge plantations indicate bark beetle activity is already occurring. Therefore, as stand hazards are moderate to high and there area locally-active bark beetle populations, bark beetle-caused tree mortality is likely to occur within during the temporal management horizon of this project (≈ 20-30 years).

Management Option – Reduce Plantation Stocking

Multiple experimental research studies have assessed density reduction treatments and consistently report that thinning is a viable tool to reduce bark beetle-caused tree mortality in ponderosa pine plantations (Fettig et al., 2007). A synopsis of relevant research, study findings, and quantifications of stand density and tree mortality levels is provided in Appendix B. Stand-level thinning to residual spacing targets, even in stands adjacent to active bark beetle caused-mortality centers, has been effective in reducing MPB-caused ponderosa pine mortality in the Joseph Creek (Hall, 1964; Hall and Davies, 1968) and Sugar Hill plantations (Oliver, 1995; Egan et al., 2010) on the Modoc National Forest. However, thinning plantations without spacing targets can leave a clumped distribution of residual trees with high local density values that remain susceptible to bark beetle-caused tree mortality (Whitehead, 2010; J. Egan personal observation based on monitoring of plantation treatments in Sierra-Nevada Mountains).

Stand-level thinning can reduce inter-tree competition and promote long-term benefits as residual trees gain greater access to limited commodities (light, water, nutrients, and overall growing space) (Oliver and Larson, 1990). Residual trees in thinned plantations exhibit increased tree growth, vigor, resilience to bark beetle attack, and drought-related tree mortality. Thinning treatments can also enhance residual tree resilience to WPB-attack by altering stand microclimate; in effect, reducing environmental conditions conducive towards bark beetle dispersal, communication, aggregation, and/or reproduction. Microclimate variables thought to be important include pheromone plume stability, wind speed, and bark temperature. (Amman and Logan, 1998; Thistle et al., 2004).

A certified, Forest or District silviculturist should be consulted for site-specific thinning recommendations and/or prescriptions. General guidelines recommend thinning to or below 60% of maximum stand density index (SDI) or reducing basal area to less than 80% of "normal"

for a given site can reduce inter-tree competition and the risk of bark beetle-related mortality. These targets are consistent with direction from a previous Regional Forester that indicated treatments should be designed "to ensure that this level will not be reached again for at least 20 years after thinning" (Appendix C - Regional Forester Letter attached).

Management Option – Removal of Disease-Infected Trees in Stand #27

Elytroderma disease incidence in stand #27 trees was at low levels during our visit; however, intra-tree infection rates may increase as branch infections spread to new growth. Additionally, inter-tree infection incidence may increase as stand #27 appears to be in a location and/or experienced a recent weather event favorable to disease spread. Discriminating against infected tree retention during thinning treatments can reduce the number of trees within the stand anticipated to have disease-related physiological stress and susceptibility to bark beetle-caused mortality. Trees with "*E. deformans*-caused branch flagging or witches' brooms within 6 feet of their leaders" should especially be considered for removal (USDA, 2008).

Funding to reduce stand hazard associated with bark beetle-caused tree mortality may be available through the Western Bark Beetle initiative on a competitive basis. Please contact Forest Health Protection staff for additional information on this funding opportunity or with any additional forest health-related questions.

I would like to thank Carl Graves and Brian Block, Calaveras Ranger District Foresters, for providing plantation background information, stand inventory data, field accompaniment, and a project map to support this evaluation.

Thank you for your time,

/s/ *Joel M Egan*

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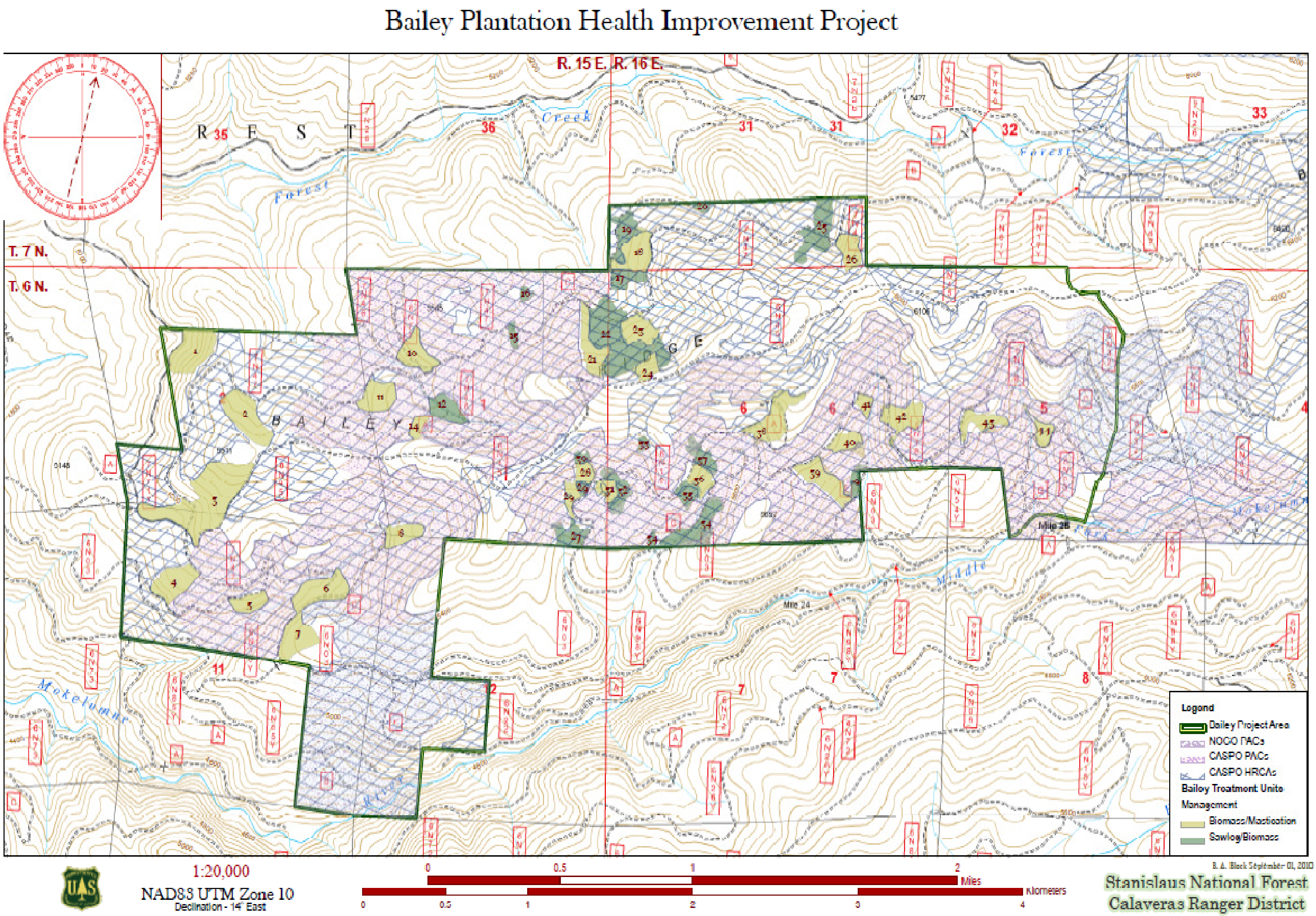
Appendix A – Map Depicting Plantation Stands Proposed for Treatment within the Bailey Ridge Project Area. Map Provided by Brian Block, Calaveras Ranger District Forester, on 8/31/10.



Appendix B – Table of Pertinent Thinning and Bark Beetle-Caused Mortality Research with Study Findings, Stand Density, and Tree Mortality Levels.

Experimental research on thinning and bark beetle-caused mortality in ponderosa pine and white fir forests

Location	Reps	Time Period	Thinned Density (Tree Mortality) vs Non-Thinned Density units (Tree Mortality units)	Study Findings	Literature cited
			Studies in Ponderosa Pine Forests		
Northeast CA - Warner Mnts	1	1961-1965	23 (13-26 or 4-12%) vs 64 m^2/ha (542 trees/0.4 ha or 38%) [a]	Thinned plot less conifer mortality; vigor and microclimate both appear as mechanisms	Hall and Davies 1968
Northeast OR - Sumpter Valley	1	1967-1972	3.5 (.75), 4.5 (.06), 5.5 (.00), 6.5 (.00) vs no spacing m (2.7 m^2/ha BA) [b]	Thinning reduced conifer mortality; thinning + direct control no different than thinning alone	Sartwell and Dolph 1976
Black Hills, SD - Black Hills NF	1	1979-1980	10 (0), 17 (0), 20 (3.5) vs 45 m^2/ha BA (14 trees/ha/year), 42 (28), 46 (17) [c]	Thinning reduced conifer mortality in case study	McCambridge and Stevens 1982
Northeast CA - Lassen NF	3	1980-1994	18 (0.0), 23 (0.0), 32 (0.5) vs 44 m^2/ha BA (6.0 trees/ha/year)	Thinning reduced conifer mortality	Fiddler et al. 1989
Black Hills, SD - Black Hills NF	1	1986-1989	14 (<1), 18 (<1), 23 (.66) vs. 29 m^2/ha BA (3% BA) [d e]	Thinning reduced conifer mortality in case study - BA threshold around 28 m^2/ha BA	Schmid and Mata 1992
Northeast OR - Blue Mnts	3	1959-1989	2.7, 3.1, 3.8, 5.2 (m spacing) vs no spacing	82% of mortality in >200 SDI; thinning reduced the density of mortality at alpha=.10	Cochran and Barrett 1993
Northeast CA - Warner Mnts	1	1959-1995	25, 50, 128 vs 157 SDI	Mortality threshold for NE CA at 230 SDI; self-thinning ruled by *Dendroctonus* in NE CA	Oliver 1972 & Oliver 1995
North CA - Eliott Ranch	3	1970-1995	73,128,183, 238 vs 293 SDI [f]	Mortality threshold for NE CA low productivity sites at 183 SDI or BA >23 m2/ha	Oliver 1997
North WA - Methow Valley	3	1958-1988	4, 5.7, 8.0 vs 1.3 m spacing [g]	Majority of mortality SDI >250; mortality switched from suppression to MPB-caused at 17.8 cm QMD	Cochran and Barrett 1998
Black Hills, SD - Black Hills NF	1	1986-2004	14 (9), 18 (53), 23 (48) vs 35 m^2/ha GSL (77%) [e]	Thinning plots surrounded by unmanaged forest may not reduce stand susceptibility to mortality	Schmid and Mata 2005
			Studies in White Fir Forests		
Central OR - Freemont NF	3	1991-1995	112 (7-27), 168 (14-46), 224 (24-63), 280 SDI (19-79% trees/ha) [h]	Density and percent mortality positively related to host density; thinned plots all had mortality	Cochran 1998

[a] Density (trees ha^{-1} killed) mortality and percent mortality (trees ha^{-1} killed / trees ha^{-1} of available host) for the 3 thinned plots presented as ranges; percent mortality calculated by dividing density of mortality from 1 non-thinned plot by estimate of available density of host from data taken on 19 variable radius plots of surrounding unmanaged forest

[b] designed for 2 but 1 was accidentally logged and destroyed for research purposes

[c] Case study data shown for each thinned then each respective non-thinned paired plot where mortality data averaged for the 2 years sampled

[d] Percent mortality is average of 3 years sampled [e] 10 reps in experiment - 1 reported in this study [f] Thinning first occurred with GSL targets then SDI targets over course of experiment

[g] Study did not indicate mortality levels for each spacing treatment

[h] Range of percent mortality results reported from three Freemont NF blocks that experienced fir engraver-caused mortality; all plots thinned in this experiment

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Appendix C – Conifer Forest Density Management for Multiple Objectives, Prior Regional Forester Direction, dated July 14, 2004.

United States Department of Agriculture

Forest Service

Pacific Southwest Region

Regional Office, R5
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Vallejo, CA 94592
(707) 562-8737 Voice
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File Code: 2470/5150/3400

Route To:

Date: July 14, 2004

Subject: Conifer Forest Density Management for Multiple Objectives

To: Forest Supervisors and Directors

When we met at McClellan on April 21, I voiced my concern about density related forest health and agreed to clarify our direction and my expectations. This is part of the serious forest health problem in the Region and we need to be more proactive in addressing the density situation. This is necessary if we are to stem the spread of tree mortality and reduce fuel conditions supporting large fires.

The problem is most evident in Southern California where an extended period of increasing forest densification and now drought has resulted in unacceptable tree mortality across thousands of acres. Drought conditions that are currently occurring can be expected to continue. The situation has lead to severe fire risks including potential loss of life, cast a heavy economic cost to the local communities, and created a significant impact on the natural resources.

The Southern California situation is not unique. Forest health problems are emerging elsewhere. Tree mortality is now evident and spreading across the Southern Sierras. Many forested areas now have stand densities that exceed their biological potential density considering current drought conditions.

The Region's Fireshed Assessment Process provides an integrated approach to address desired conditions on a landscape. Thinning activities should be designed to achieve the multiple objectives of increased resistance to damage from crown fires, reduced surface/ladder fuels, reduced insect damage, and inter-tree competition, and restoration of densities more characteristic of the past under the influence of natural fire regimes. Placed properly on the landscape, thinnings also help protect denser forest patches with important habitat function from damage by wildfire. Economic considerations should be considered as well. When we address these objectives as part of fuels and vegetation management, our forests will be healthier and our work will be more efficient. I am aware of situations where projects have been planned and implemented to meet more limited objectives by treating only surface/ladder fuel and postponing upper canopy thinning, or by thinning so lightly that health risks return in too short a period of time. Projects must be viewed to meet multiple objectives and be effective for longer timeframes.

Therefore, when designing thinnings ensure that density does not <u>exceed</u> an ***upper*** limit (for example: 90% of normal basal area, or 60% of maximum stand density index); this is a prudent way to avoid the health risks associated with density. Design thinnings to ensure that this level will not be reached again for at least 20 years after thinning.

The Directors of NRM (lead), EC, EP, FAM, and S&PF will continue to coordinate and provide oversight of these efforts. Also the Directors will assist forests in achieving better density management by including this topic in reviews and functional assistance trips, and by incorporating density management principles in relevant training sessions (for example: Fireshed Assessment Process Training, Silvicultural Certification Training, Continuing Education in Fuels Management Training).

/s/ Bernie Weingardt (for)
JACK A. BLACKWELL
Regional Forester

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